NATIONAL BUREAU OF STANDARDS REPORT

8169

An Investigation of Beam-Spreading Techniques
for
Semiflush-Prismatic Type Airport-Marker Lights

By

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U. S. DEPARTMENT OF COMMERCE
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1. INTRODUCTION

Semiflush-prismatic type airport-marker lights have vertical beam spreads of approximately 4° and are designed to have beam elevations of 1.5°, 3.0°, or 4.5°, depending on their intended location relative to the reference point of the runway. When located in a displaced threshold, and, more particularly during conditions of reduced minimums, a light of even a 4.5° beam elevation does not provide sufficient guidance where needed, namely, up to about 12° elevation. This report gives the results of a preliminary investigation undertaken with a view to modifying existing lights to provide a broader vertical beam spread at something more than an elevation of 4.5°.

2. MATERIAL USED

The basic unit used for the test was a type BB45 light (with a 1/2 inch projection above the runway), designed for a beam elevation of 1.5°. The measured vertical beam spread at 50% of peak intensity using a typical 200-watt, 6.6-ampere lamp with stippled cover, was approximately 4°.

Lamps used in the unit during the test are described in Table I.

3. PROCEDURE AND RESULTS

3.1 General Photometric Procedure. The photometric equipment and methods used are described in Sections 2.1a and 2.3a of NBS Technical Note 198 (NBS Report 7410). The photometric distance was 30 meters. Each lamp was operated at its rated current or voltage.

3.1.1 Unit with Auxiliary Condensing Lens. A cylindrical condensing lens was placed between the lamp and the entrance face of the prism. This lens was plano-convex, approximately 2-1/2 inches by 4-1/4 inches, with a focal length of 2.58 inches. It was mounted with the convex side up and toward the prism. No provision was made for accurately positioning the lens for optimum performance or repeatability. Hence, the lens position was not necessarily the same for each of the figures included in the report.

Comparative measurements with and without the auxiliary lens with lamps numbered 2, 4, and 6 are shown in Figures 1, 2, and 3, and are summarized in Table II.

Figures 4 and 5 are representative horizontal intensity distributions.

Table I

Lamp Number	Lamp Type	Cover	Filament	Power (watts)	Rating	Peak Intensity[1] (kilocandelas)	Beam Spread at 10% of Maximum[1] (degrees) Horiz.	Vert.
1	200PAR Locomotive	Clear	CC-8	200	30 volts	260	11	11
2	6.6A/PAR56/3[2]	Stippled	CC-6	200	6.6 amperes	150	11	9
3	Experimental	Clear		300	20 amperes	-	-	-
4	20A/PAR56/2[2,3]	Stippled	CC-6	300	20 amperes	250	18	7
5	Experimental	Clear	CC-6	450	25 volts	-	-	-
6	20A/PAR56/3[2]	Stippled	CC-6	499	20 amperes	425[4]	15[4]	11[4]

[1] Manufacturer's data (except [4]).
[2] See also NBS Report 21P-23/60.
[3] See also NBS Reports 21P-91/62, -11/60, and -3/59.
[4] From NBS Report 21P-9/60.

Table II

Lamp Number	Lamp Type	Auxiliary Lens	Vertical Beam: Peak Intensity (kilocandelas)	Vertical Beam: Beam Elevation (degrees)	Vertical Beam: Spread at 50% of Peak (degrees)	Figure Number
2	6.6A/PAR56/3	No	4.7	1.0	4.2	1
		Yes	5.5	7.5	15.1	1
4	20A/PAR56/2	No	9.5	2.0	4.6	2
		Yes	6.6	7.0	16.2	2
6	20A/PAR56/3	No	12.8	2.4	7.0	3
		Yes	13.0	7.0	15.4	3

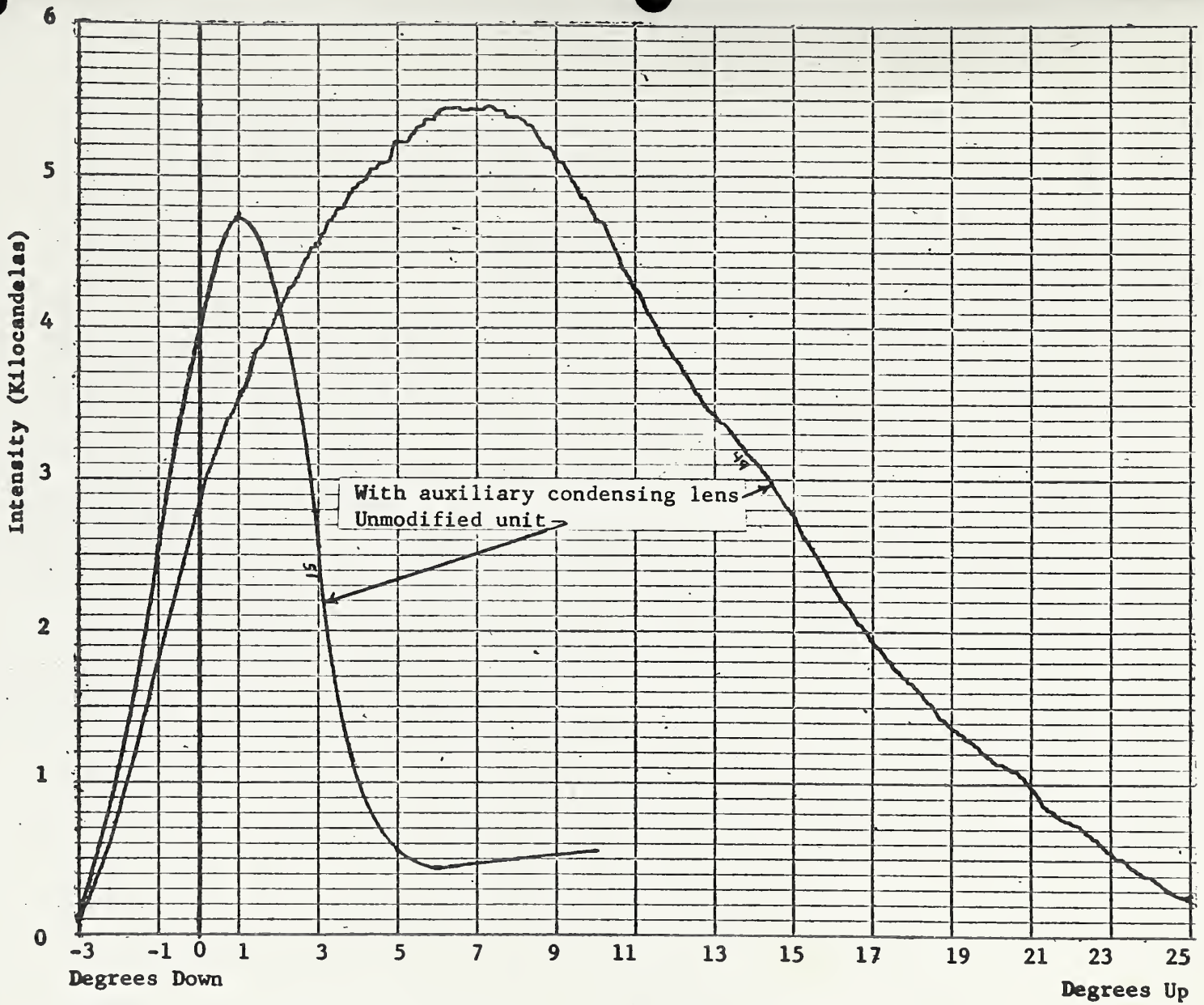

Figure 1. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt type 6.6A/PAR56/3 lamp operated at 6.6 amperes. NBS Report 8169

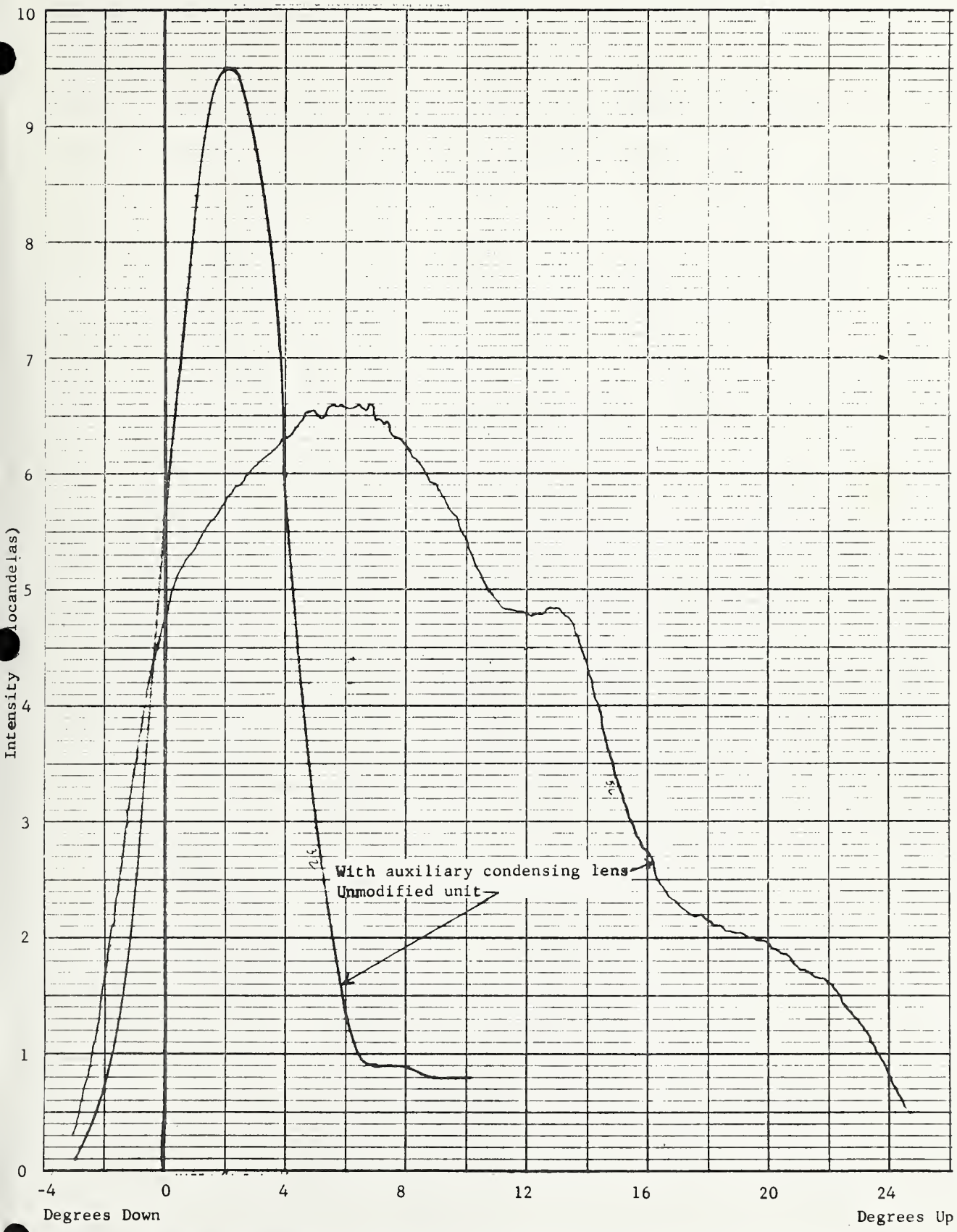

Figure 2. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 300-watt, type 20A/PAR56/2, lamp operated at 20 amperes. NBS Report 8169

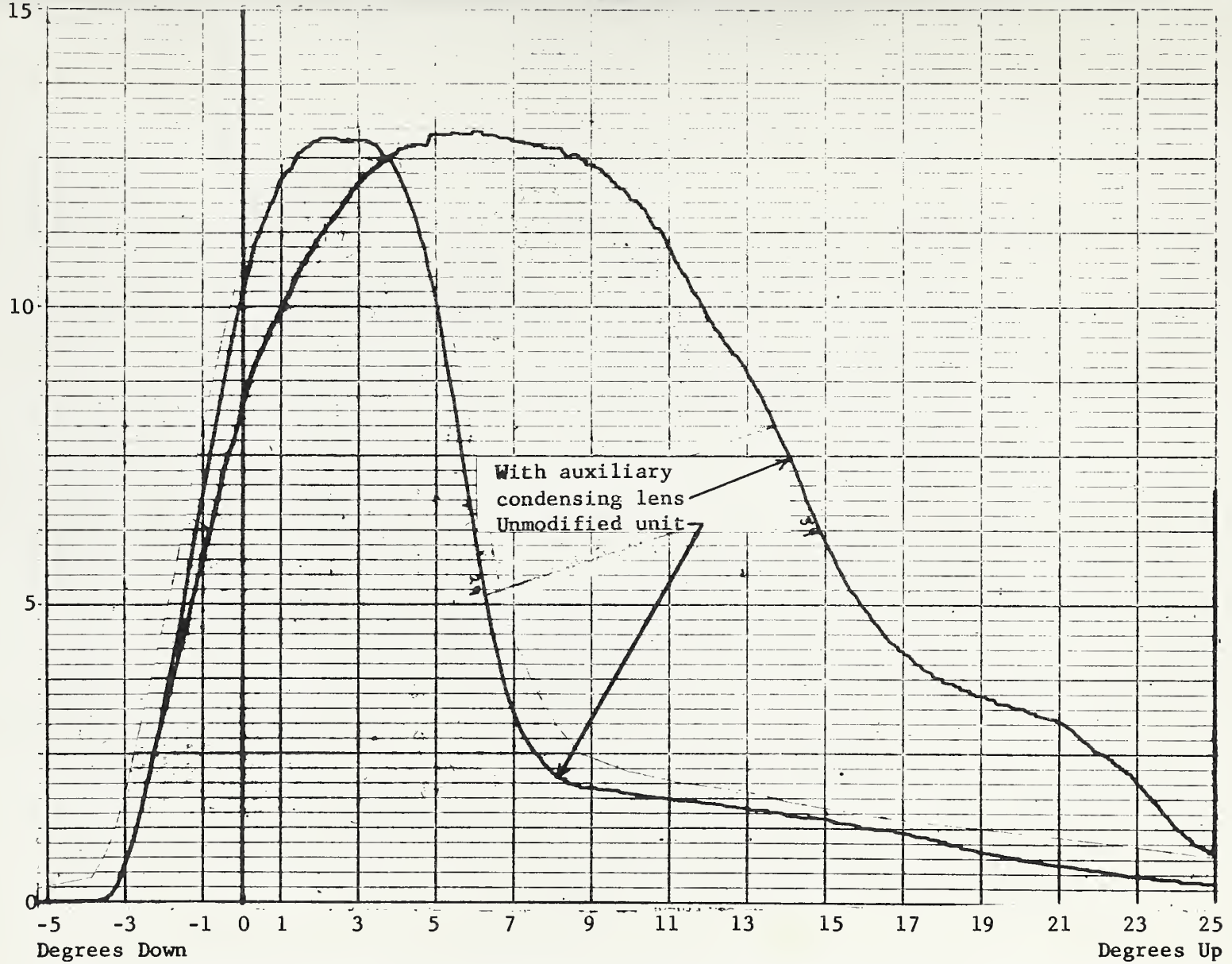

Figure 3. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 499-watt, type 20A/PAR56/3, lamp operated at 20 amperes.

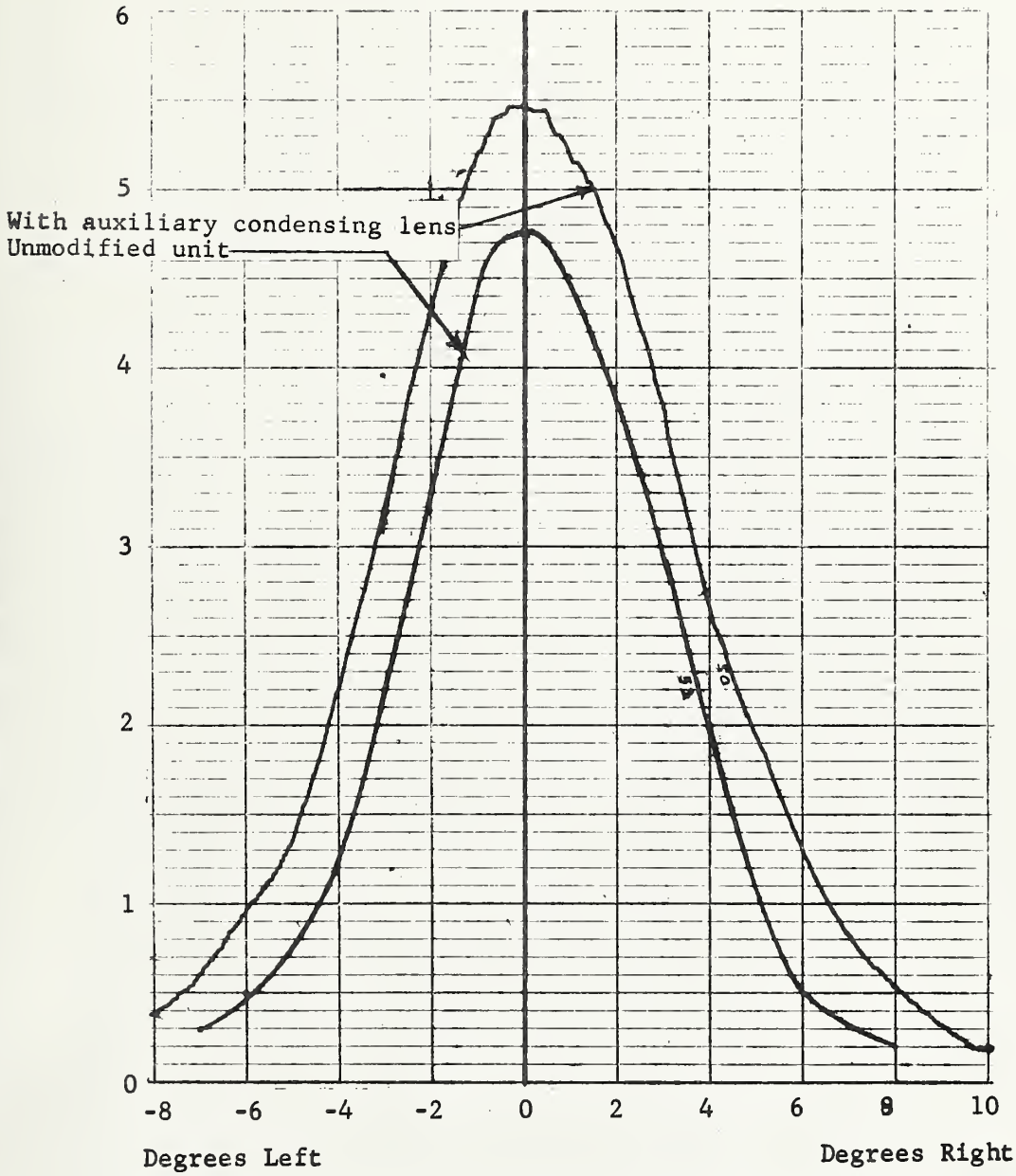

Figure 4. Horizontal intensity distributions through the vertical beam axis of a type BB Prismatic Approach and Runway Light with a 200-watt, type 6.6A/PAR56/3, lamp operated at 6.6 amperes.
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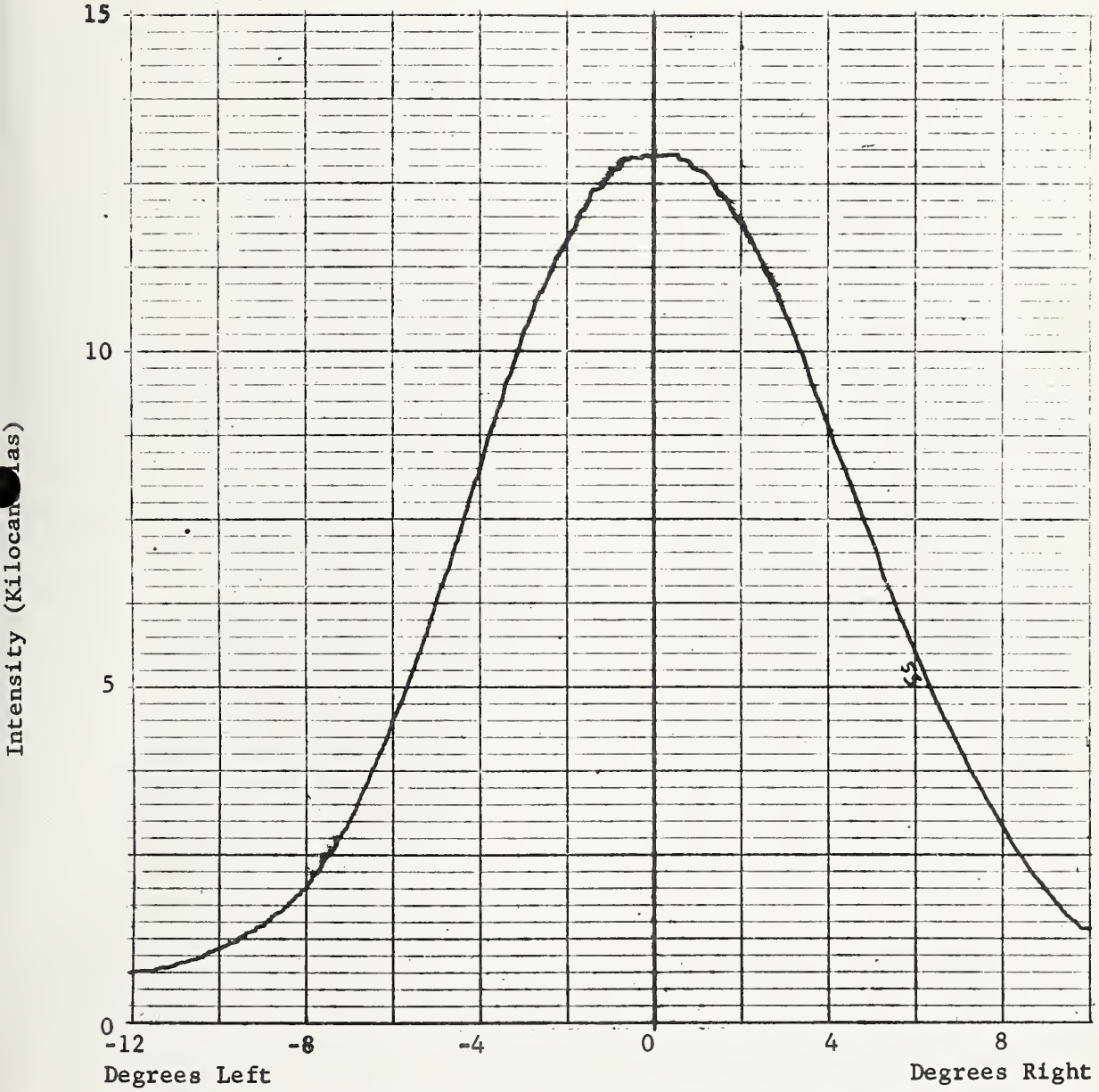

Figure 5. Horizontal intensity distribution through the vertical beam axis of a type BB Prismatic Approach and Runway Light with a 499-watt, type 20A/PAR56/3 lamp operated at 20 amperes.
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3.1.2 Other Lamps. Single vertical intensity distributions were made of the unit without the auxiliary lens using lamps number 1, 3, and 5 of Table I. These include a narrow-beam locomotive headlight lamp and two experimental airport lamps. The results obtained are summarized in Table III, taken from Figures 6, 7, and 8.

Table III

Lamp Number	Lamp Type	Peak Intensity (kilocandelas)	Beam Elevation (degrees)	Beam Spread at 50% of Peak (degrees)	Figure No.
1	200 PAR Loco.	6.4	1.3	3.8	6
3	300-watt exp.	9.7	1.1	3.9	7
5	450-watt exp.	18.3	2.4	6.3	8

3.1.3 Effects of Lamp Tilt. In order to evaluate the effects of lamp tilt on beam elevation, washers 0.04 inch thick were placed between the lamp holder ring and one supporting leg, as shown in Figure 9.

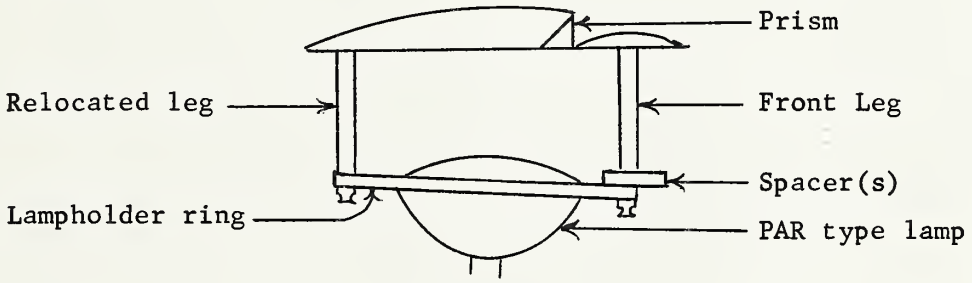

Figure 9. Location of spacer(s) used to tilt lamp. The front leg supporting the lampholder was left in its regular place. The two other legs were removed and one was relocated diametrically opposite the front leg.

The center-to-center distance between the two supporting legs was 7.25 inches. Each spacer, therefore, tilted the lamp 19', or approximately 1/3°. The maximum tilt (with 6 washers) was 1°54'. The vertical intensity distributions taken with different lamp-tilt angles are shown in Figure 10, from which the data of Table IV are taken.

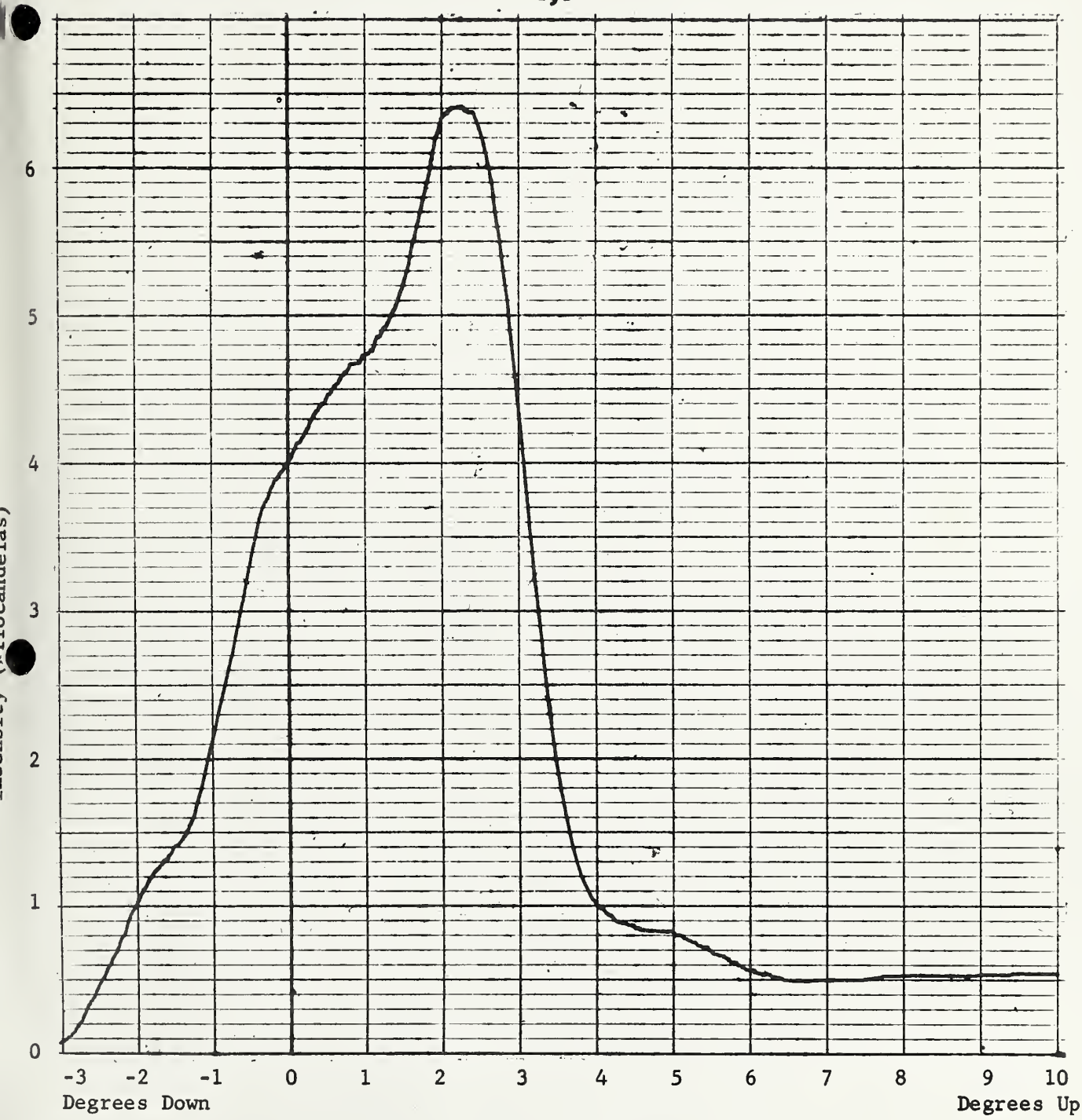

Figure 6. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt, type 200PAR, Locomotive lamp operated at 30 volts.
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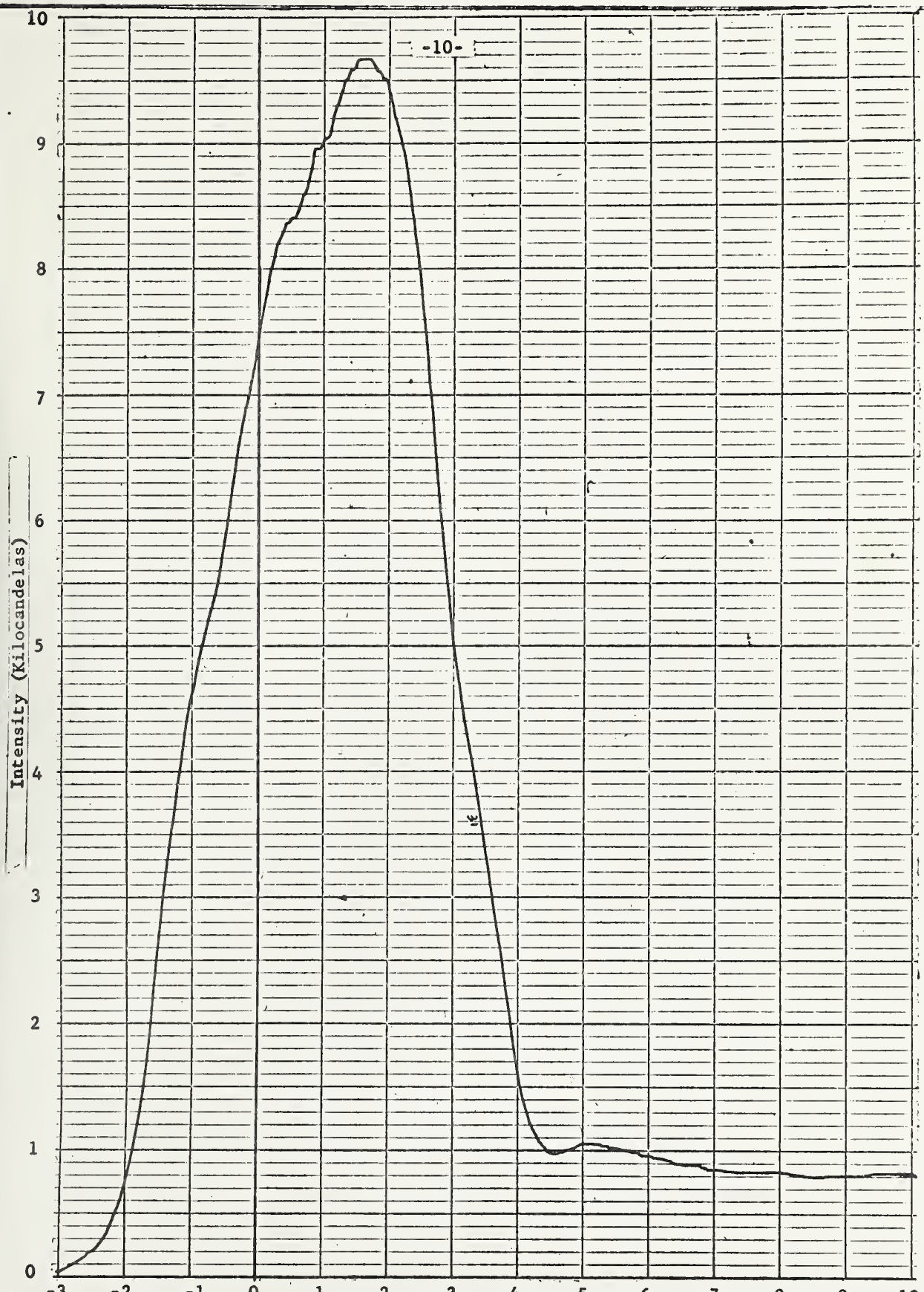

Figure 7. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with an experimental 300-watt, 20-ampere lamp with a clear cover, operated at 20 amperes.

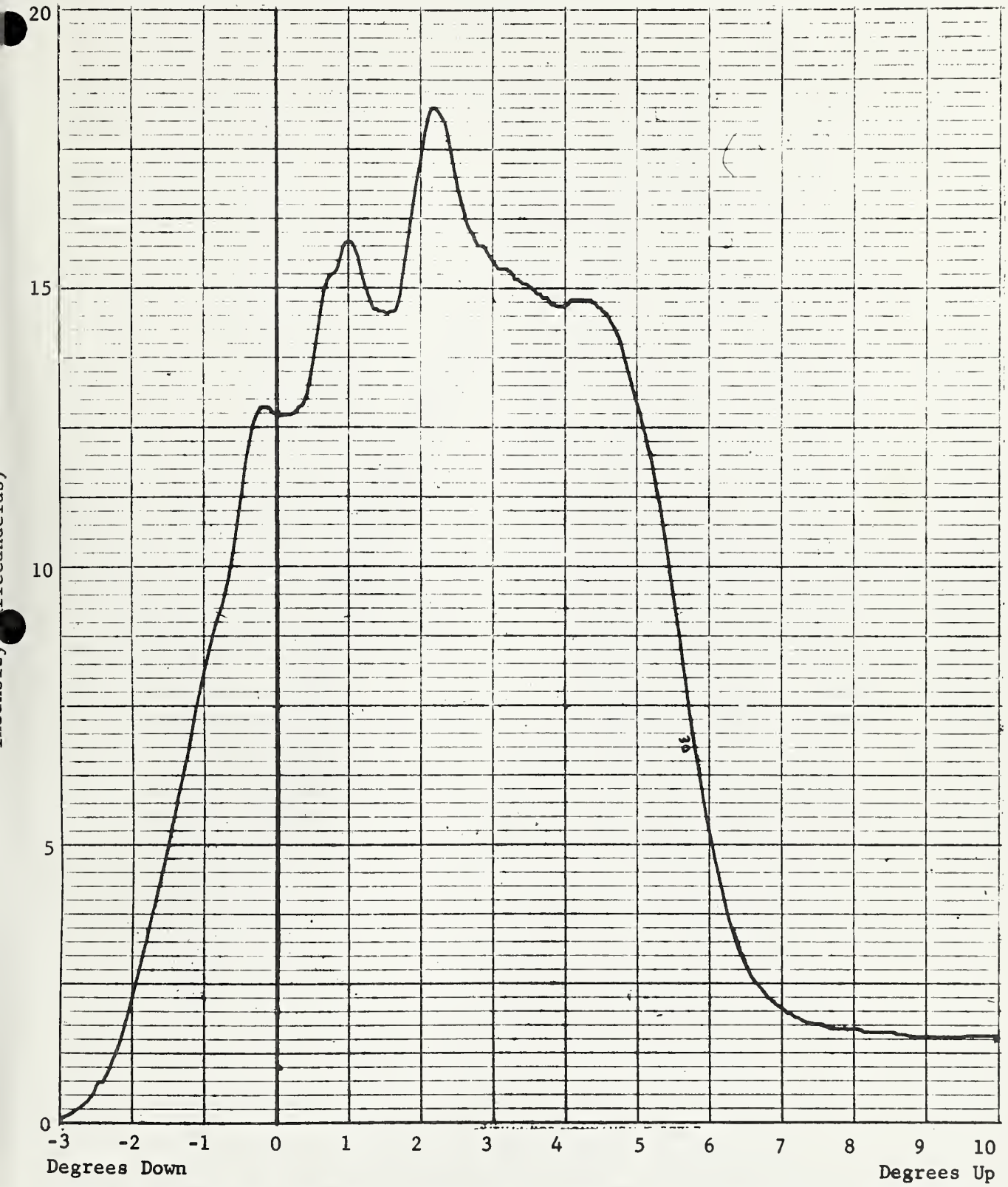

Figure 8. Vertical intensity distribution through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with an experimental 450-watt, 25-volt lamp operated at 25 volts.

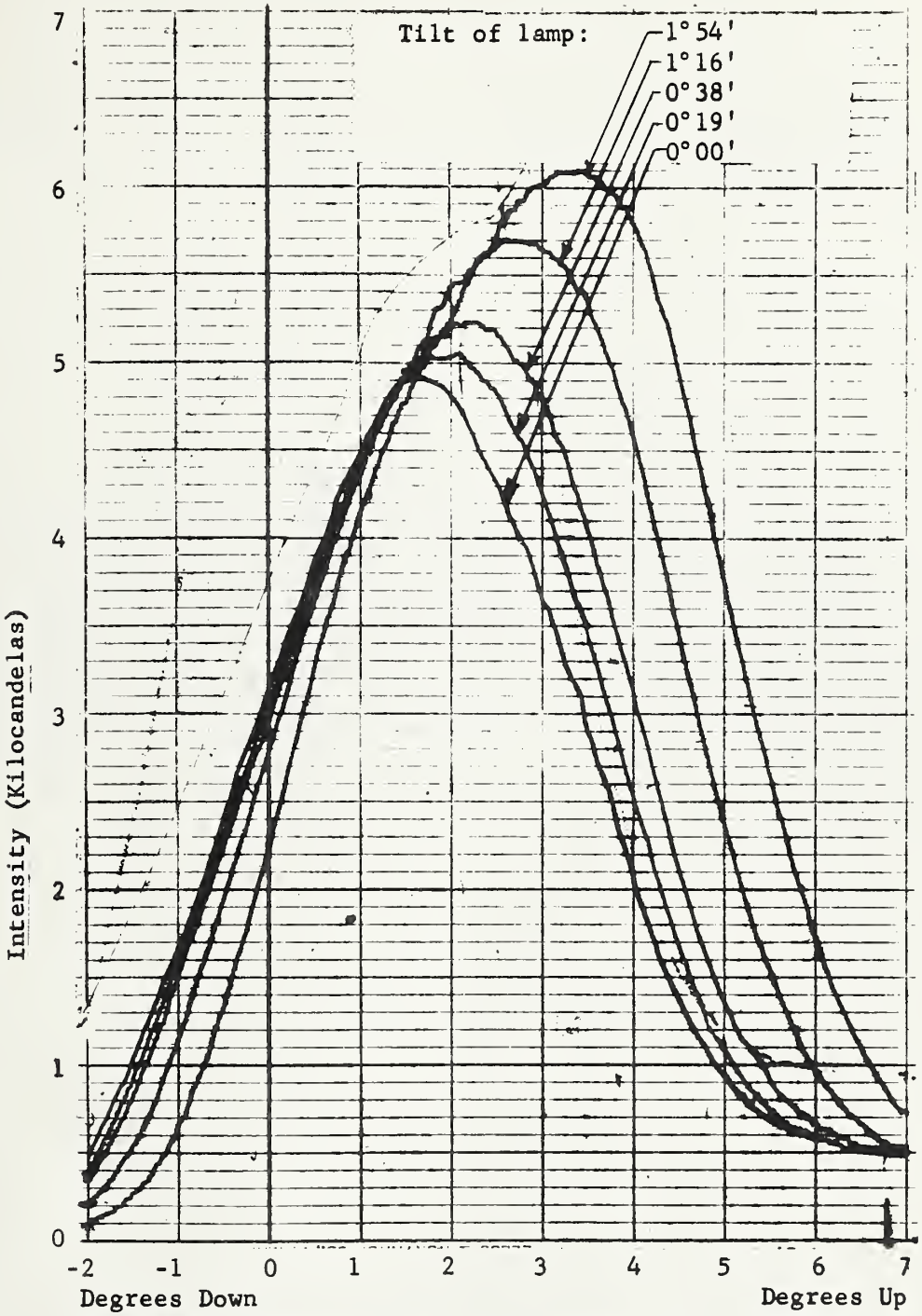

Figure 10. Vertical intensity distributions through 0.0° horizontal of a type BB Prismatic Approach and Runway Light with a 200-watt, type 6.6A/PAR56/3 lamp operated at 6.6 amperes. The lamp and holder were tilted by means of spacers.
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Table IV

No. of Spacers	Angle of Tilt	Peak Intensity (kilocandelas)	Elevation of Beam Axis (degrees)	Beam Spread at 50% of Peak (degrees)
0	0	4.9	1.6	4.3
1	0°19'	5.1	1.8	4.3
2	0°38'	5.2	2.0	4.5
4	1°16'	5.7	2.4	4.7
6	1°54'	6.1	2.8_5	4.9

4. CONCLUSION

The data of Tables I and II, and, to a lesser degree, those of Table III, show that more effective use can be made of the flux available from the lamp in a prismatic type light by using an auxiliary lens, and that the angle of elevation of the beam can be changed by lamp selection, by lamp tilt or by the use of an auxiliary lens. The results given in this report are intended only to demonstrate the effectiveness of the use of these methods of modifying the intensity distribution of the light and should not be considered as showing the optimum choice of design parameters.

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